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Joint Warfighting Experimentation: Ingredients for Success

Joint Advanced Warfighting Program

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Abstract: This paper presents a view of concept-based joint warfighting experimentation as a disciplined process of discovery. In presenting this view it describes what joint warfighting experimentation is (and what it is not), why it is needed, why it won't be easy, and how it can be done effectively.

Keywords: Joint warfighting experimentation, innovation, Red Teaming, Joint Vision 2010 (JV 2010), Joint Vision 2020 (JV 2020), DOTMLPF, Attack Operations Against Critical Mobile Targets.

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JAWP

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September 1, 2000

The Joint Advanced Warfighting Program (JAWP) began its work by reviewing prior military experimentation efforts, surveying ongoing activities (primarily of the Services), and examining the tools available. From these early efforts we developed a set of ideas about what would constitute an effective program of experimentation. These ideas were honed over several months in discussions among the JAWP staff and in conversations with the US Joint Forces Command (formerly US Atlantic Command), other unified commands, the Joint Staff, the Services, and the Office of the Secretary of Defense.

At the same time, the JAWP began to develop exemplar operational concepts and to think through the joint experimentation required to learn how to make them work. One of these concepts, *Attack Operations Against Critical Mobile Targets*, was selected by the US Joint Forces Command to be the first joint experiment. At their request, the JAWP led the development of the concept and executed the associated experiment. The experience pushed our thinking about experimentation beyond the theoretical, and made it possible to generate a more thoughtful discussion of joint warfighting experimentation—what it is (and isn't), why it's needed, why it won't be easy, and how it can be done effectively.

There are alternative views on how to do joint experimentation. The view we espouse is of concept-based experimentation as a disciplined process of discovery, in which most of the real learning takes place in venues other than big field activities, and there is as much value from creative military people deducing "what might be" as there is in measuring what happened.

Comments and questions are invited and should be directed to

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PREFACE

This report was prepared for the Director, Defense Research and Engineering, in the Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics, under the task order Joint Advanced Warfighting Programs (JAWP). It addresses the task order objective of generating advanced joint operational concepts and joint experimentation to assist the Department of Defense in attaining the objectives of Joint Vision 2020. Members of the JAWP contributed to the ideas and review of this report.

The report is based in part on presentations given by members of the JAWP to various audiences. It also draws from the draft final report of the *Attack Operations Against Critical Mobile Targets* experiment, prepared by a team led by MG (Ret) Larry Budge, USA; and papers written by Dr. Robert Worley of IDA and Col Jack Jackson, USAF, of the JAWP. Other members of the JAWP also contributed to the ideas and review of this report.

The JAWP was established at IDA by the Office of the Secretary of Defense and the Joint Staff to serve as a catalyst for stimulating innovation and breakthrough change. The JAWP Team is composed of military personnel on joint assignments from each Service as well as civilian analysts from IDA. The JAWP is located principally in Alexandria, Virginia, and includes an office in Norfolk, Virginia, that facilitates coordination with the United States Joint Forces Command.

This report does not necessarily reflect the views of the Institute for Defense Analyses or the sponsors of the JAWP. Our intent is to stimulate ideas, discussion, and, ultimately, the discovery and innovation that must fuel successful transformation.

Recent and Forthcoming Publications of the Joint Advanced Warfighting Program

Red Teaming: A Means for Transformation, John F. Sandoz, author, IDA Paper P-3580, forthcoming, January 2001.

FY2000 End of Year Report: Volumes I, II, and III, Theodore S. Gold et al., authors, IDA Paper P-3571, forthcoming, November 2000.

US Army and US Marine Corps Interoperability: A Bottom-up Series of Experiments, Rick Lynch, Tom O'Leary, Tom Clemons, and Doug Henderson, authors, IDA Paper P-3537, forthcoming, November 2000.

Developing Metrics for DoD's Transformation, Joel B. Resnick, IDA Document D-2528, October 2000.

Experimentation in the Period Between the Two World Wars: Lessons for the Twenty-First Century, Williamson Murray, author, IDA Document D-2502, October 2000.

Lessons Learned from the First Joint Experiment (J9901), Larry D. Budge and John Fricas, authors, IDA Document D-2496, October 2000.

Military Operations in Urban Terrain: A Survey of Journal Articles, D. Robert Worley, Alec Wahlman, and Dennis Gleeson, Jr., IDA Document D-2521, forthcoming, October 2000.

The Joint Experiment J9901: Attack Operations Against Critical Mobile Targets. Joint Advanced Warfighting Program, September 29, 2000. Prepared for the US Joint Forces Command.

Joint Strike Force Operational Concept, Joint Advanced Warfighting Program, forthcoming, September 13, 2000.

Joint Warfighting Experimentation: Ingredients for Success, James H. Kurtz, author, IDA Document D-2437, September 2000.

Joint Advanced Warfare Seminar, James H. Kurtz, Daniel E. Moore, and Joel B. Resnick, authors, IDA Document D-2346, July 1999.

Workshop on Advanced Technologies and Future Joint Warfighting, April 8–10, 1999: Summary of Proceedings, William J. Hurley, Phillip Gould, and Nancy P. Licato, authors, IDA Document D-2343, May 1999.

Framework for Joint Experimentation—Transformation's Enabler, Karl Lowe, author, IDA Document D-2280, January 1999.

Contemplating Military Innovation, IDA Document D-2191, Dennis J. Gleeson, author, August 1998.

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SUMMARY

Warfighting experimentation is a process of discovery. It differs from other military activities, such as training exercises, tests, and demonstrations. It aims to explore new and innovative combinations of doctrine, organization, and materiel; assess their feasibility; evaluate their utility; determine their limits; and foster their co-evolution into new capabilities.

While the Services experiment routinely as they upgrade the capabilities they provide to the joint force, there is also a direct need for joint experimentation aimed at the operational level of war. Recent experience suggests that the demands placed on joint force commanders – integrating air, land, sea, and space capabilities to successfully execute military operations – will be even greater in the 21st Century. A variety of new threats and potential combat environments confound attempts to codify future requirements. An effective program of joint experimentation can help by exploring the alternatives and defining new pathways to more effective joint capabilities. It offers insurance against surprise and provides the means by which hard lessons can be learned and acted upon before US forces once again find themselves in combat.

Joint warfighting experimentation won't be easy, particularly if its objective is transformation – which can be succinctly described as big change. Change in large organizations is always difficult. It requires resources that are almost always in demand for other purposes. It requires, too, an uncommon blend of creativity, discipline, and open-mindedness. Experimentation to develop and refine advanced warfighting concepts must account for complex situations, capable and cunning adversaries, and human performance under extreme stress. Success in future operations will come to the side that can deliver decisive effects against the opponent's critical capabilities in a time sequence that disrupts his ability to plan and react. Identifying and measuring the specific effects needed to assure success will be a real challenge in operations where information, speed, and distributed precision attacks – not the traditional mass, lethality, and broad offensive action – will make the difference.

In designating the Commander in Chief, US Joint Forces Command, as the Executive Agent for Joint Warfighting Experimentation, the Department of Defense (DoD) took a major step toward managing these challenges. By conducting a wide-ranging program of joint experimentation, US Joint Forces Command can help ensure that future joint force commanders have the "born joint" capabilities they will need to integrate and employ to greatest effect the capabilities being developed by the Services.

An effective experimentation program directed toward transformation will display certain essential ingredients. Together, these may be viewed as a recipe for success.

- **Experiment in the Proper Context**
  - **Focus on discovery and creation, not merely evaluation**
  - **Learn from past experiments, and experience**
  - **Recognize 2010 and 2020 as azimuths, not destinations**
  - **Integrate, leverage, and seek to influence Service efforts**
  - **Include international and interagency participation**
  - **Protect the process . . . and the participants**
- **Experiment Right**
  - **Provide for early immersion in the future**
  - **Feature Red Teaming at every stage**
  - **Treat experiments as extended campaigns, not one-time events**
  - **Be tolerant of "failure" and open to surprise**
- **Use the Results Smartly**
  - **Seek early success without sacrificing bold goals**
  - **Be prepared to exploit success**
  - **Involve stakeholders and provide persuasive results**
  - **Aim at co-evolution of doctrine, organization, training, materiel, leaders, people, and facilities (DOTMLPF)**

A Recipe for Effective Joint Warfighting Experimentation

The first joint experiment, *Attack Operations Against Critical Mobile Targets*, incorporated several of these ingredients, including a concept-based iterative process, aggressive Red Teaming, and a tolerance for surprise. Other characteristics essential for transformation, including early and vigorous involvement of key stakeholders, remain to be incorporated in future experiments.

Joint Warfighting Experimentation: Ingredients for Success

A. What Warfighting Experimentation Is (and Isn't)

Warfighting experimentation is a process of discovery about new military operational concepts and capabilities. It is the process of systematically exploring new and innovative combinations of doctrine, organization, training, materiel, leadership, people, and facilities (DOTMLPF) to assess their feasibility, evaluate their utility, determine their limits, and foster their co-evolution into fielded capabilities.

Experimentation differs from other military activities, such as training exercises, tests, and demonstrations.

- Training exercises focus on proficiency in executing current doctrine, using current organizations and equipment. They offer limited utility for exploring new concepts, organizations, and materiel.
- Tests focus on whether a system (some combination of hardware and software) works. Experimentation tests ideas, not things.
- Demonstrations focus on showcasing success to persuade skeptics and build consensus around a concept. Experimentation seeks outcomes (such as driving a concept to failure) that would be unacceptable in a demonstration.

B. Why Experimentation Is Needed, and Why Some Experimentation Must Be Joint

For most of the Cold War, DoD built a military force to deter America's principal adversary and reassure our allies. When the Soviet-Warsaw Pact threat disappeared, the focus of DoD force planning was lost. DoD was still struggling to understand what kind of force the US would need – and could afford – to fulfill its role in the world when the Chairman of the Joint Chiefs of Staff published his vision for building a force with dramatically improved capabilities.

With technological innovation and information superiority as key enablers, Joint Vision 2010 established "full spectrum dominance" as the goal, implying a force that can dominate the full range of potential threats from the outset of any contingency. Its successor document, Joint Vision 2020, extended the notion of innovation to include experimentation and the importance of exploring "changes in doctrine, organization, training, materiel, leadership and education, personnel, and facilities as well as technology."[1]

The congressionally-mandated National Defense Panel noted that achieving the kinds of capabilities embodied by "full spectrum dominance" would entail transforming the armed forces into a very different kind of military. The Panel recommended greater emphasis on experimenting with a variety of military systems, operational concepts, and force structures, because "it is this combination of technology, emerging military systems, new concepts of operation and force restructuring that often produces the discontinuous leap in military effectiveness characteristic of revolutions in military affairs."[2]

The Secretary of Defense supported the National Defense Panel's thrust toward transformation to exploit a possible revolution in military affairs, and cited Service Battle Labs and Warfare Centers as examples of experimentation efforts under way.[3] A more recent Defense Science Board review of DoD's transformation efforts found activities involving advanced concept development and experimentation in all the Services – activities that seemed to be of high quality and that were considerably more substantive than found by studies conducted a few years earlier.[4]

Service-specific experimentation is indeed essential to ensure the continued evolution of core competencies in the forces provided to joint force commanders by the Army, Navy, Air Force, and Marine Corps. And while new technologies, particularly information technologies, are important to the realization of Service visions, it is humans – soldiers, sailors, airmen, and Marines – who will drive the outcome of engagements, battles, and campaigns. Discovering the limits and consequences of human performance should be an essential focus of all experimentation.

For example, the Defense Science Board and others have postulated that small, distributed ground elements – given reliable, broad-band communications, superb situation awareness, and access to remote fires – could exert as much battlespace influence as a much larger force and be more responsive, agile and adaptive.[5] Such a distributed force could have at its disposal all the "things" that have until now been the

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[1] *Joint Vision 2020,* p. 11.

[2] *Transforming Defense: National Security in the 21st Century*, Report of the National Defense Panel, December 1997, p. 57.

[3] Secretary of Defense letter to Committee Chairmen, 15 December 1997.

[4] *Report of the Defense Science Board Task Force on DoD Warfighting Transformation,* Office of the Under Secretary of Defense for Acquisition and Technology, September 1999.

[5] See, for example, the *Report of the Defense Science Board 1996 Summer Study Task Force on Tactics and Technology for 21st Century Military Superiority,* Office of the Secretary of Defense, October 1996.

reason for assembling large formations. But what should such a force look like? What kind of leader will it need, with what kind of skills? What are its vulnerabilities? Only systematic experimentation can explore such questions.

There is also a need for experimentation that is joint. Historically, DoD has not had a joint approach for determining capabilities and force structure. Each Service has developed its own doctrine, organizations, and materiel and trained its units, leaders, and people, according to its own warfighting concepts. There have been multi-Service concepts, but few analyses in support of a weapon system have been cast in the context of joint force capabilities.

As a result, joint commanders at the operational level have been challenged to integrate sets of Service capabilities in whose development their point of view was hardly represented. Too often, Service systems that need to be integrated into a joint "system of systems" cannot talk to one another. Information collected by one Service's sensors that would increase the effectiveness of another's shooters cannot be shared because technical interfaces and formats differ from Service to Service. Assuring interoperability can increase costs and delay the introduction of needed capabilities; thus, from a force provider's perspective, it can make sense to sacrifice interoperability in favor of reducing cost or shortening the development cycle. But from the perspective of the joint force commander, who must integrate and employ all the capabilities the Services provide to the joint force, it makes little sense, if any.

The interests of future air, land, sea, and space commanders are well represented in the DoD force development process by the four Services. In the past, however, the voice of future joint force commanders – who will have direct responsibility for integrating those same air, land, sea, and space capabilities – have had little influence in decisions that determined the effectiveness of joint forces.

What is more, recent operational experience suggests that the demands placed on joint force commanders to successfully execute military operations will be even greater in the coming decades. While the US and its allies have enjoyed considerable success, a candid review of operations reveals that the factors of information, time, distance, and tempo present new problems. Issues of strategic agility, command and control, theater missile defense, and control and distribution of fires all suggest the necessity for a systematic investigation of new joint warfighting possibilities.

Absent the defining crucible of the Cold War and Soviet military power against which to measure US military capabilities, we cannot be certain what combinations of doctrine, organizations, and technologies will be important for operational success. A variety of new threats and potential combat environments confound attempts to codify future needs using a Cold War requirements system. An effective program of joint experimentation can help by exploring alternatives and defining pathways to new and more effective joint capabilities.

The Commander in Chief, US Joint Forces Command, has been given responsibility to represent joint force commanders of the future in developing concepts and capabilities.[6] By conducting a wide-ranging program of joint experimentation, US Joint Forces Command can help ensure that future joint force commanders get both the interoperability and the "born joint" capabilities they need to integrate and employ to greatest effect the capabilities being developed by the Services.

C. WHY JOINT WARFIGHTING EXPERIMENTATION WON'T BE EASY

Change in large, tradition-bound organizations is always difficult. A program of experimentation is an effort to institutionalize a process for change, which runs counter to the tendency of bureaucracies to ensure survival by sustaining the status quo. Experimentation that aims at big change – transformation – will inevitably stimulate resistance. Experimentation that does not serve to support or further advance existing programs will be viewed with suspicion and subject to much debate and criticism.

Systematic experimentation requires resources that are almost always in demand for other purposes. It requires, too, an uncommon blend of creativity, discipline, open-mindedness, and support from the top – but can be stifled by too much top-down direction.

Experimentation to develop and refine advanced warfighting concepts must account for complex situations, capable and cunning adversaries, and human performance under extreme stress. Without the Soviet yardstick to measure ourselves against, there is an absence of consensus among DoD components about what capabilities are needed most. Experimentation also requires appropriate tools, particularly modeling and simulation. Joint and Service visions of future operations have in common the need for precision and speed to dominate an information-rich battlespace. Success will more likely come to the side that can tailor the right response and deliver decisive effects against the opponent's critical capabilities in a time sequence that disrupts and confounds

[6] Department of Defense News Release 252-98, *U.S. Atlantic Command Designated Executive Agent for Joint Warfighting Experimentation,* May 21, 1998.

his ability to plan and react. Identifying and measuring the specific effects needed to assure success will be a real challenge in operations where information and distributed precision attacks – not the traditional mass, lethality, and broad offensive action – make the difference. Complex, dynamic, precision operations will be difficult to replicate credibly without new models and new confederations that enable real-time human-in-the-loop interaction with technologies and organizations.

In designating US Joint Forces Command as the Executive Agent for Joint Warfighting Experimentation, DoD took a major step toward overcoming these inherent challenges. But supporting organizations are immature at best, and truly joint processes and procedures have to be invented.

D. A RECIPE FOR EFFECTIVE EXPERIMENTATION

The following discussion assumes that joint warfighting experimentation has transformation as its primary objective. It should focus on learning about concepts that can lead to a breakthrough in the overall capability of joint forces. To help define the parameters of a joint experimentation program and keep it oriented on big change, the following are offered as ingredients essential for effective experimentation.

1. Experiment in the Proper Context

Focus on discovery and creation, not merely evaluation

The object of experimentation is innovation – tinkering with new ideas to discover those worth pursuing. Creative leaders, with a passion for ideas they believe in, are at the heart of successful innovation. Examples can be cited in every Service:

- Army officers Billy Mitchell, Henry H. Arnold, Carl Spaatz, Ira Eaker, and James H. Doolittle championed the idea of air power long before they dreamt of a United States Air Force.
- While still a junior officer, William S. Sims made such a nuisance of himself that the Navy finally adopted, against the judgment of many of its leaders, his continuous-aim firing methods. Years later, as President of the Naval War College, he pioneered the use of wargaming and joined other visionaries such as William Moffett, Joseph Reeves, and Jack Towers in pushing the Navy to experiment with aircraft carriers.
- Marine Corps Major Earl H. Ellis was the intellectual father of amphibious warfare, but it took the support of Commandant John H. Russell and the energy of true believers like Holland M. Smith to turn the concept into a fielded capability.

- Generals James Gavin, Hamilton Howze, Harry W.O. Kinnard, and others who saw clearly the potential of helicopters as a means to achieve tactical mobility drove the Army to experiment with, and ultimately embrace, the concept of air mobility.[7]

Creative leaders generally have gathered around themselves a team of enterprising individuals who share their belief in an idea and committed themselves to making it work. Admiral Moffett knew which officers shared his vision of naval aviation and influenced their assignments to create critical mass around the idea. General Kinnard, when told by the Army Chief of Staff to pick a few men to help determine how far and how fast the Army should go in embracing air mobility, knew exactly which few to pick. But assembling a team of creative people with a shared passion will be more difficult in the joint world, because the Services control assignments and career imperatives – skill progression, command, and professional military education – impact on the availability of people with the requisite talents.

Learn from past experiments, and experience

Transformation is at its root a process. It can be slow and methodical, or it can happen quickly: for example, the first combat use of air power occurred only 11 years after the Wright Brother's first flight. The process must be tailored to fit specific times and specific institutions, but valuable insight can be gained by studying prior efforts that brought about big change, as well as those that failed.

Much of the attention currently paid to past military innovation focuses on the years between World Wars I and II. More recent examples include the Army's air mobility experimentation and rebuilding effort after Vietnam; the Army-Air Force development of air-land battle doctrine, and the Navy's efforts to develop architectures that ultimately enabled implementation of the Cooperative Engagement Concept.

Today, all the Services are conducting experiments to develop and refine their future operational concepts. The lessons they learn in doing so are an ideal starting point for joint concept development and experimentation.

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[7] To learn more about these successful efforts at innovation, and others not so successful, see Elting E. Morison, *Men, Machines, and Modern Times,* The Massachusetts Institute of Technology Press, 1966; Stephen Peter Rosen, *Winning the Next War: Innovation and the Modern Military,* Cornell University Press, 1991; *Military Innovation in the Interwar Period,* edited by Williamson Murray and Allan R. Millett, Cambridge University Press, 1996; General Hamilton H. Howze, Ret., "Army Aviation 1955-1962: The Foundation of Air Mobility" in *Army Aviation*, December 31, 1992, pp. 26-34; and Lieutenant General Harry W.O. Kinnard, Ret., "Army Aviation in 1963-1972: The 'Golden Age' Begins" in *Army Aviation,* December 31, 1992, pp. 36-46. For a study of prior military experimentation efforts, see Williamson Murray, *Experimentation in the Interwar Period: Lessons for the Twenty-First Century,* IDA Document D-2502.

Recognize 2010 and 2020 as azimuths, not destinations

An ancient proverb says, "When the wise man points at the moon, only a fool stares at his finger." JV 2010 pointed toward a military force able to dominate any situation in which it is committed. It is a goal, not the date by which the force is to be fielded. Some of the capabilities envisioned in JV 2010 and its successor documents may be achievable in a few years, others may be as distant as the moon.

Experimentation must be understood as a process for change, not a schedule . . . a journey, not a destination. The important thing is to start, and to learn along the way.

Integrate, leverage, and seek to influence Service efforts

Service participation is crucial to successful joint warfighting experimentation, not only to obtain the Services' buy-in, but also – and more importantly – to capitalize on their energy and resources. Joint experimentation that does not involve the Services risks becoming just one more "stovepipe."

The Services are the institutions that organize, train, and equip military forces. They have the experience, expertise, and resources to develop concepts and requirements to fulfill the roles assigned to them by Congress. They have the wherewithal to initiate and manage programs that develop and acquire new capabilities. Each Service looks at its portion of the battlespace and does its own concept development and experimentation to determine and develop the capabilities it thinks the joint force will need. A key objective of joint experimentation must be to influence and integrate future Service capabilities – to develop joint employment concepts that will allow the capability of the joint force as a whole to be greater than the sum of its Service parts.[8]

Include international and interagency participation

The National Security Strategy of the United States says that while we will not hesitate to act unilaterally where necessary, we prefer to act in concert with the international community whenever possible.[9]

A gap between American and allied military capabilities, highlighted in operations in Kosovo, remains a concern. As more sophisticated command-and-control and support capabilities emerge in the US armed forces, some gaps seem certain to widen. Experimentation to develop new military concepts and capabilities will have to

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[8] For a framework that shows how Service and joint operational concepts can relate to and reinforce one another, collectively producing capabilities greater than the sum of their individual contributions, see Karl Lowe, *A Framework for Joint Experimentation – Transformation's Enabler,* IDA Document D-2280.

[9] *A National Security Strategy for a New Century,* The White House, December 1999.

explore roles that selected allies can reasonably be expected to play. Involving allies early in the concept development and experimentation process will help persuade them to take full advantage of experimental "discoveries" in transforming their own capabilities.

Protect the process . . . and the participants

Experiments are harbingers of change, and change is threatening. Innovative endeavors, and especially the innovative people that drive them, need uninterrupted support from the top. The process of innovation requires protection from bureaucratic reprisals, but not from criticism. Protection includes managing expectations – inside as well as outside the process – so that undue criticism does not flow from unreasonable fears or unrealistic expectations.

Admiral William Moffett, as head of the Navy's Bureau of Aeronautics, supported and protected naval aviation in its infancy. He secured legislation so that only aviation officers could command Naval Air Stations and aircraft carriers. He invited senior officers from the surface Navy to gain aviation wings as "observers" without having to go though the full training program for pilots. And he placed these observers in aviation commands, where they were eventually replaced by younger officers who had grown up in aviation.[10]

Providing cover and protection for those involved in developing and promoting advanced joint warfighting concepts will be a challenge in the joint world. Because promotions and assignments are controlled by their parent Services, officers may be understandably reluctant to champion joint concepts that do not conform to conventional Service wisdom.

2. Experiment Right

Provide for early immersion in the future

Thinking about the future is hard, but essential to innovation. To overcome the natural hesitancy to confront an uncertain future, we now have the ability to create a virtual environment, place innovative operators in the middle of it, and challenge them to discover what they can accomplish with new organizations; command-and-control arrangements; and tactics, techniques and procedures. Placing new technologies into such an operational context – letting real people play with simulated future systems – connects the operator to the technologist and links "concept push" to "technology pull."

[10] Rosen, *Winning the Next War,* pp. 76-79.

In creating such a future environment, it is necessary to make informed judgments about the performance of systems that do not yet exist. Then, given a range of performance, the objective is to determine how valuable such systems might be. This means asking operators to employ the future systems in different ways in a simulated battle or campaign, then letting the results drive development of the concept and, ultimately, of real systems.

Feature Red Teaming at every stage

Aggressive Red Teaming is key to ensuring that results of experimentation are robust and persuasive. Failure to expose a concept to Red Teaming can lead to adoption of a doctrine incapable of countering more forward-looking concepts that a potential enemy might develop. An example is the Maginot Line. Built at great cost during the 1930s to prevent the violation of French territory, the Maginot Line did well most of the things it was designed to do. But its designers failed to extend the defenses all the way to the English Channel, and instead relied on terrain (the Ardennes Forest) and allies (the Belgian Army) to protect the left flank and buy time for organizing French defenses. The designers never anticipated the fast-moving mechanized forces, dive-bombers, and Blitzkrieg tactics that, in the end, made the Maginot Line irrelevant. A "Red Team" – encouraged to challenge the effectiveness of the defensive chain when it was still in the design stage – could have uncovered its weaknesses.[11]

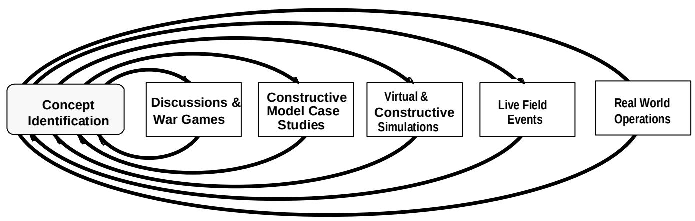
The US Navy's nuclear submarine force provides a model. Members of this community were given wide latitude to examine any number of counters to US nuclear submarine capabilities, and directed to report their findings directly to the Chief of Naval Operations without bureaucratic interference. The key is to pit a robust Blue Team against an innovative and aggressive Red Team, letting both sides learn and adapt as they go so that both sides help improve the effectiveness of the Blue concept.

Treat experiments as extended campaigns rather than one-time events

Experimentation aimed at discovery is by its very nature an iterative process. The first step in military experimentation is development of a concept – a new, integrated set of doctrine, organization, training, materiel, leadership, and personnel – intended to perform some function. Iterative trials within a single experiment may increase confidence that the results are not a one-time fluke and that the concept under consideration can be robust over a range of conditions. More importantly, iterative

[11] Rudolph Chelminski, "The Maginot Line," *Smithsonian,* June 1997, pp. 90-100.

experiments are essential, because the goal is to learn about the concept, and a single experiment is not likely to reveal all there is to learn. An experimentation campaign is therefore progressive in nature, with the results of one experiment informing and shaping the design of the next.



- **Starting point -- a preliminary concept**
- **Process is:**
  - **iterative**
  - **progressive . . . push the concept to failure**
- **A variety of tools can be used**
- **Not every experiments need to culminate in a live event**
- **End point -- a fully developed concept ready for prototype development and testing**

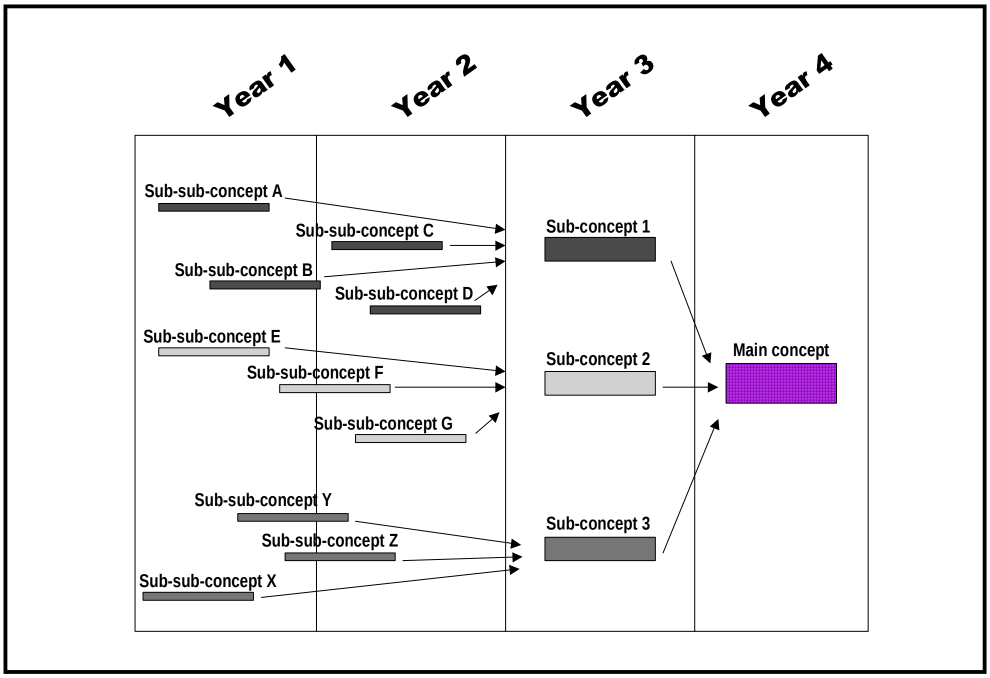
Concept Development and Experimentation

Some argue, for example, that, in the future, technology will allow distributed ground forces to mass effects without having to mass the large formations typical of past conflicts. Such a concept entails significant risks, and reason demands that implementation be preceded by confidence that we have the people; organizations; systems; connectivity; training; and tactics, techniques and procedures to do the job. Gaining the necessary degree of confidence could involve a progression of small and medium-sized experiments before putting them all together in some large event to see how well the overall concept works.

An example of a “small experiment” is one conducted at IDA’s Simulation Center for the 1996 Defense Science Board Summer Study. Army and Marine Corps lieutenants and captains were assembled, given information sufficient to establish “situation awareness,” formed into two-man teams, given a mission, and asked to formulate a plan, which they executed in an interactive simulation. At the end of each “run,” changes were made based on the teams’ recommendations. Two-man teams became three-man teams.

The information they were given changed, as did the way it was displayed. Such an event may be termed a "small experiment" – discovering what a team of junior officers can do, given certain technological advantages.

This suggests a need to deconstruct major concepts into sub-concepts and sub-sub-concepts that can explored and evaluated in small-scale, individual experiments. Once the sub-concepts have been refined, and confidence is gained in their feasibility and effectiveness, they can be integrated into more complex concepts for larger experiments. Eventually, the larger concepts can be integrated into a single concept for a more comprehensive series of experiments to explore the complete concept end to end. The following diagram illustrates this idea.



Progressive Experimentation

In years one and two, relatively simple sub-sub-concept experiments are conducted, and the results are integrated into three "medium-sized" sub-concept experiments in year three. In year four, all the parts are integrated for a "large experiment" to explore the complete concept. Throughout this process, sub-concepts will change – some will be improved, others may fail. Failure of a critical sub-concept could cause the complete concept to be rejected, but it is more likely that the learning that takes place in the early stages will cause the overall concept to be strengthened and refined.

The experiments in year four will also gain from the lessons learned in the preceding three years.

The diagram also illustrates why continuous experimentation is essential for developing and testing breakthrough concepts. If these experiments were conducted in sequence rather than in parallel, it would take at least 12 years to complete the exploration of the concept – not exactly the kind of timeline associated with a breakthrough. This kind of continuous experimentation builds momentum for transformation by providing a flow of new ideas and new approaches that build confidence in – and support for – the transformation concepts.

Experiment events may include seminars and wargames to explore and refine the concept. Since experimentation often involves the exploration of capabilities that do not yet exist, simulation plays an important role. Constructive simulations provide some quantitative insights, particularly about the expected performance parameters of future systems. However, constructive simulations do not take into account the key parameter of human performance. Human-in-the-loop (HITL) virtual simulation is therefore an essential tool, as it will permit learning about the interface of human operators with new technology, under conditions of stress, while facing a thinking, adaptive Red Team. HITL simulation will also allow human operators to evolve the concept by trying different tactics, techniques, and procedures – doing this with constructive simulation requires rewriting software code for every new idea.

Field simulations involving live forces are another experimental tool, one that may culminate an iterative, progressive campaign. However, not all experimentation needs to culminate in live field experiments. Field events do offer credibility, but they also bring their own artificiality. Variables become numerous and difficult to control, and repetition is much more difficult. Field events also attract visitors and, despite good intentions, can turn into something more akin to a demonstration than a true experiment.

Be tolerant of "failure" and open to surprise

Success in experimentation lies in discovering what works and what does not. It is disappointing to learn that a cherished idea is not as good as it first seemed, but a failed idea does not represent the failure of experimentation. The Chairman of the Joint Chiefs of Staff clearly understands the nature of experimentation and is willing to underwrite setbacks:

> "Joint experimentation will demand original thinking . . . . No doubt there will be occasional failures, but that doesn't concern me. Thomas Edison conducted 50,000

> experiments to develop a new storage battery. Asked if failures frustrated him, he replied: 'What failures? I now know 50,000 things that don't work.' Experimentation means the freedom to fail, because it is through such failures that we discover truths which help the next experiment. Thus we will ultimately reap the benefits of a *JV 2010*-capable force."[12]

Equally important is openness to the discovery that an idea works in ways different from what was anticipated. This requires that experiments be observed by people with the experience and judgment to see not only what takes place before their eyes, but also what might have happened if conditions or procedures had been even slightly different.

3. Use the Results Smartly

Seek early success without sacrificing bold goals

The United States Congress and other institutions, inside and outside government, are clearly looking for "transformation" even if they are not clear on how to measure progress. DoD (and more specifically US Joint Forces Command) needs to demonstrate progress to assure continued support for the experimentation program. Early success can demonstrate progress towards transformation and focus attention on the important issues associated with implementing the positive results of joint experimentation.

Be prepared to exploit success

Given the processes of government and the lead times associated with major change, even revolutionary change must proceed in evolutionary stages. When the objective is big change, however, it is essential to establish bold goals along an evolutionary path. The approach must be ambitious, lest big change be submerged in a tide of comfortable incrementalism. DoD cannot wait until all experiments are completed to begin planning for incorporation of ideas and concepts generated during experimentation. It takes time to develop and procure new materiel, but the other elements that together comprise a capability – doctrine, organization, training, leaders, people, and facilities – have their own cycles and lead times as well. The experimentation process must foster the co-evolution of all the elements – DOTMLPF – which, when combined, will produce a new capability.

Transformation can be thwarted by the rigidity of processes that allocate resources needed to implement and exploit new concepts. Flexibility is essential. Success must be anticipated and a process put in place to move promising experimental

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[12] General Henry H. Shelton, "A Word From the New Chairman," *Joint Forces Quarterly*, Autumn/Winter 1997-98, p. 8.

products and results rapidly into the field, outside the normal cycle of budget preparation and review.[13]

The Predator Unmanned Aerial Vehicle, for example, proved itself highly effective at providing near-real-time, beyond-line-of-sight imagery when deployed to Bosnia as an Advanced Concept Technology Demonstration. Predator's success in real-world operations led to a decision to field it on a permanent basis, but implementation was slowed because insufficient consideration had been given to force structure and personnel issues.

Involve stakeholders and provide persuasive results

Achieving the right set of capabilities for joint force commanders of the future to dominate any adversary will require not only difficult doctrinal decisions, but also difficult investment decisions. Such decisions could be helped by experimental results, provided all stakeholders accept them as valid. To obtain the necessary buy-in, stakeholders must be involved in developing the ideas and concepts to be assessed. The process must immerse stakeholders in experiments – to let them "test drive" the ideas themselves.

General Hamilton Howze was a former tank commander, not an aviator, when he was named the Chief of Army Aviation. He was told he'd been chosen on the basis of his strong belief that mobility was the real key to battlefield success.[14] General Howze later wrote that one of the jobs he considered vital was selling all the pertinent parts of the Army on the proposition that many things useful to do in combat might be done in the air at a very low altitude.

> "To that end, we wrote the Command and General Staff College at Ft. Leavenworth to get the tactical problems they were currently presenting to their students; these we presented to any individual or group of officers we could get to listen. First we gave the problem straight, as C&GSC gave it; then we put a very few selected, attached light reconnaissance aircraft, attack aircraft, and troop-carrying aircraft on one side, but not the other, and presented the problem again; then we shifted the aircraft to the other side and gave it a third time.
>
> "The effect of a few aircraft on the outcome was astonishing. One side knew much more of the other's position, disposition, and activity; one could move critically-needed supplies or persons quickly, the other couldn't; one could cross part of its strength over hills and

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[13] For a discussion of the extent to which such a process exists within DoD, see *Report of the Defense Science Board Task Force on DoD Warfighting Transformation,* September 1999.

[14] Interview with General Howze by Colonel Glenn A. Smith and Lieutenant Colonel August Cianciolo, *The History of Army Aviation, Senior Officer Debriefing Program,* Carlisle Barracks, PA, US Military History Institute, quoted in Rosen, *Winning the Next War,* p. 73.

> rivers easily, the other couldn't. Indeed, one could beat hell out of the other, other things (besides aircraft) being equal. The little show was immensely convincing."[15]

Planning and executing a successful program of joint warfighting experimentation needs to take into account who the stakeholders are and what sort of results each is likely to accept as persuasive.

Aim at co-evolution of DOTMLPF

The object of experimentation is to discover and refine new military capabilities – new combinations of advanced technology (materiel), organization, and doctrine (tactics, techniques, and procedures). Each of these elements of capability has its own development cycle and its own lead time, as do the closely associated training, leader development, training and education, and facilities elements. A capability implemented before all those elements are in place and functioning risks failure. Therefore, to be effective, joint experimentation must aim at their co-evolution.

E. TESTING THE RECIPE: THE FIRST JOINT EXPERIMENT

The first joint experiment, *Attack Operations Against Critical Mobile Targets,* suggests some of the difficulties as well as the paths future joint experimentation needs to follow. The concept was developed to address the problem of theater ballistic missiles (TBMs), which dates back to the V-1 and V-2 rockets of World War II. Today, TBMs continue to proliferate, and may carry nuclear, chemical, or biological weapons. Attack operations – locating and destroying such weapons on the ground – is therefore a critical challenge for US military forces.

Because it was the first joint experiment, the objectives included learning how to conduct effective experiments and building a base of knowledge and tools for future experiments, in addition to exploring new concepts for prosecuting time-critical targets. The concept envisioned that sensors and sensor management technologies will evolve in the next 15 to 20 years to the point of enabling comprehensive coverage of objects in the battlespace. These technologies hold the promise of enabling joint forces to locate, track, and then attack TBM launchers and other critical mobile targets.

The challenge in conducting attack operations will be to maneuver different kinds of sensor platforms and sensors, merge their data into "engagement quality" tracks that provide target identification and location sufficient to permit their attack, and bring

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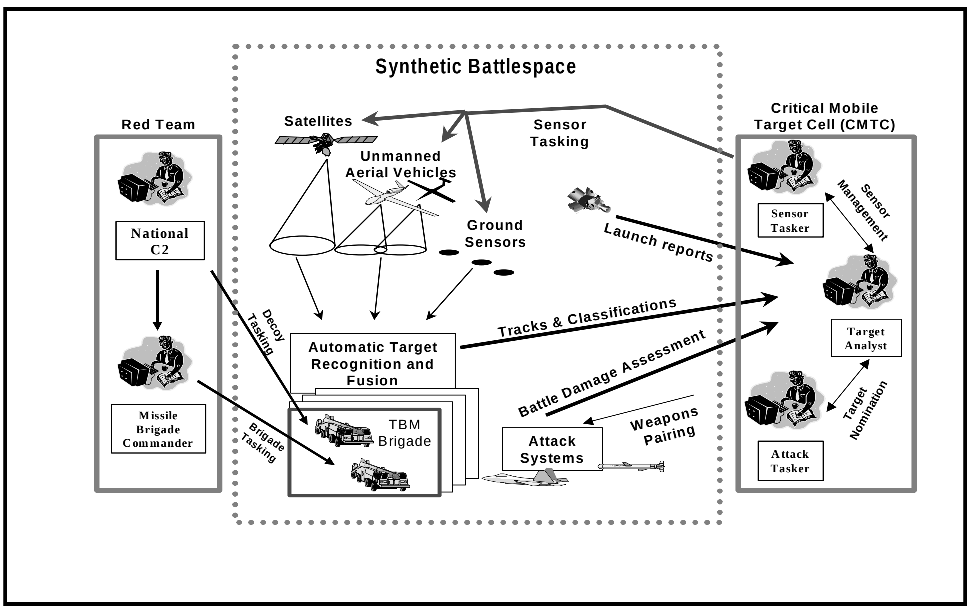
[15] General Hamilton H. Howze, Ret., "Army Aviation 1955-1962: The Foundation of Air Mobility" in *Army Aviation,* December 31, 1992, pp. 26-34.

appropriate weapons to bear, when and where the targets are most vulnerable. The idea is not only to shorten response times between detection and engagement, but more fundamentally to provide a synoptic, shared, engagement-quality picture of the battlespace to enable trained teams to anticipate, detect, and attack fleeting targets.

The focus of the *Attack Operations* experiment was on command and control – a human-in-the-loop system able to adapt as necessary to integrate target tracks from a network of simulated future sensors, maneuver those sensors, and direct a weapons network against mobile missiles and their support systems. The objective was to learn how to find and destroy the missiles and their launchers on the ground, ideally before first launch.

The experiment team used the Synthetic Theater of War (STOW) simulation, an Advanced Concept Technology Demonstration sponsored by the Defense Advanced Research Projects Agency (DARPA), to create a synthetic battlespace integrating the air, land, sea, and space domains as well as the forces that operate in them.[16]



The *Attack Operations* Experiment Pitted Blue Against Red in a Simulated Future Environment

Into this environment were placed a mix of simulated future (circa 2015) sensors and weapons, integrated by a future command and control system. Experienced operators experimented with these simulated future capabilities, exploring new methods of

[16] The STOW simulation, since renamed Joint Semi-Automated Forces (JSAF), continues to be used by US Joint Forces Command as a human-in-the-loop virtual environment for experimentation.

command and control and new tactics to improve the speed and efficiency of targeting and attack. An independent Red Team provided dynamic free-play opposition in a series of trials.

In the experiment, sensor "hits" were sent to an Automated Target Recognition (ATR) exploitation and automated fusion emulation, which calculated the probability of correct identification. This probability, along with target location, speed, and direction, was then sent to the Blue Critical Mobile Target Cell (CMTC), where target analysts tracked each target, requested additional sensor coverage when required, and passed the target to an attack tasker, who paired it with an appropriate weapon and directed the attack. The CMTC provided the essential link between the sensing and attack functions.[17]

Some attributes of effective experiments were evident in this first experiment:

- It was a process of discovery, tolerant of surprise and failure. Players were allowed, indeed encouraged, to innovate during the trials. Outcomes were not scripted.

- It involved a Red Team (perhaps the most important attribute distinguishing experiments from demonstrations and tests). The Red Team both planned and operated Red Forces. Red planners – recruited from academia, industry, and government – developed a future ballistic missile force composed of solid and liquid fuel missiles, launchers with improved mobility, and enhanced camouflage, concealment, and deception measures. Red players provided the "OPFOR" (opposing force) to contest the Blue players during the human-in-the-loop portion of the experiment. Red was encouraged to develop tactics – such as salvo fires, "shoot and scoot" techniques, and enhanced camouflage, cover, and deception – reasonably available to an enemy in the 2015 time frame. Red and Blue were both allowed freedom to adapt internal processes and modify tactics, techniques, and procedures.

- It provided early immersion into the future so that subsequent experiments can explore paths to the capabilities envisioned. Set in the 2015 timeframe, it examined a mix of simulated future sensors and weapons, integrated by a future command and control system. Fully exploring the subject will require a campaign of continuous experimentation that progressively adds new variables and additional degrees of difficulty.

- It was an iterative process involving concept development, constructive modeling, and human-in-the-loop simulation. At each stage, changes were made based on results of the preceding step. If at any point the concept had "failed," the experiment could have been halted and the concept reworked to incorporate lessons learned.

[17] For a comprehensive review of lessons learned about designing and conducting joint experiments, see John Fricas, *Lessons Learned From The First Joint Experiment: Attack Operations Against Critical Mobile Targets,* IDA Document D-2496.

Perhaps not surprisingly – since this was the first experiment and the front-end planning stage was tightly time constrained – some attributes were not exhibited:

- Service involvement: The heart of the concept was a cell with the authority to task, in real time, sensors and weapons systems without regard to the owning Service. Cultural barriers traditionally prevent a Service from willingly handing over control of its assets. Fostering the changes in culture and doctrine necessary to achieve the capabilities envisioned will require including the Services as full partners in joint concept development and experimentation.

- International involvement: Because command and control is central to attack operations, and because it can succeed only if all the constituent parts of the system are interoperable, extensive participation by allies will be essential in developing the concept. Only one other nation took part in the first experiment.

- Involvement of key stakeholders: The lack of Service participation has already been cited, but perhaps even more crucial to any future implementation of the concept are the other unified combatant commanders. While the Services may fear loss of control over Service assets, joint force commanders are likely to see at once the advantages of a cell having the authority to task, in real time, sensors and weapons systems without regard to who "owns" them.

- Preparedness to exploit success: Preparing to exploit success is perhaps the major challenge facing future joint experiments. This first joint experiment did offer a set of DOTMLPF recommendations, in part to stimulate thinking about what to do with what is learned from joint experimentation. However, it remains for future experiments to consider much more seriously this formidable challenge.

F. Conclusion

An aggressive program of joint warfighting experimentation – systematically exploring new combinations of doctrine, organization, training, materiel, leadership, people, and facilities to assess their feasibility, evaluate their utility, determine their limits, and foster their co-evolution into fielded capabilities – will provide the means by which hard lessons can be learned and acted upon <u>before</u> US forces once again enter the ultimate laboratory of armed combat against an enemy of the United States.

Achieving fielded capabilities will require exploration of all the DOTMLPF elements, not just new materiel and command-and-control procedures. The first joint experiment provides a good foundation for a program of continuous experimentation aimed at co-evolving a new and much-needed capability, but more attention must be paid to integrating Service efforts, involving stakeholders, and providing persuasive results.

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This paper presents a view of concept-based joint warfighting experimentation as a disciplined process of discovery. In presenting this view it describes what joint warfighting experimentation is (and what it is not), why it is needed, why it won't be easy, and how it can be done effectively.

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